



**US Army Corps
of Engineers**
Waterways Experiment
Station

Preliminary Data Summary for July 1994 CERC Field Research Facility

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July 1994

Preliminary Data Summary

by Field Research Facility

U.S. Army Corps of Engineers
Waterways Experiment Station
Coastal Engineering Research Center
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Preface

This report provides a summary of basic oceanographic, meteorological and bottom profile data for the month. The data were obtained as part of the Measurements and Analysis work units at the U.S. Army Engineer Waterways Experiment Station, Coastal Engineering Research Center's Field Research Facility (FRF) in Duck, North Carolina. The FRF staff collected and analyzed these data. These summaries are intended to make the data readily available to all FRF users, and comments on their content and usefulness are invited.

1 Introduction

The U.S. Army Engineer Waterways Experiment Station, Coastal Engineering Research Center's (CERC) Field Research Facility (FRF) is located on the Outer Banks of North Carolina, near the village of Duck (Figure 1).

The FRF research program provides a means for obtaining high-quality field data, particularly during storms, in support of the U.S. Army Corps of Engineers' coastal engineering research missions. The research pier is a reinforced concrete structure supported on 0.9-m-diam steel piles spaced 12.2 m apart along the pier's length and 4.6 m apart across the width. The pier deck is 6.1 m wide and extends from behind the duneline to about the 6-m water depth contour at a height of 7.75 m above the National Geodetic Vertical Datum (NGVD) of the year 1929.

One of the responsibilities of the FRF research program is the collection, analysis and dissemination of data on local bathymetric, oceanographic, and meteorological conditions. This summary is intended to provide basic data as soon as possible after they are obtained. Questions and/or comments concerning the data may be directed to Mr. Clifford F. Baron at (919) 261-3511.

Chapter 2 presents the meteorological data; Chapters 3 through 6 present oceanographic data; Chapter 7 presents nearshore profiles and bathymetry; and Chapter 8, if included, documents special events that occurred at the FRF during the month.

Table 1 is a list of instruments used and their operational status during the month. Figure 2 shows weather and ocean conditions for the month. Table 2 and Figure 3 identifies the location of the instruments. The water depths at the wave gauges and current meters vary and may be determined from information contained in Figure 9. Other installation information is contained in Table 1.

Times given in the report are referenced to eastern standard time (EST).

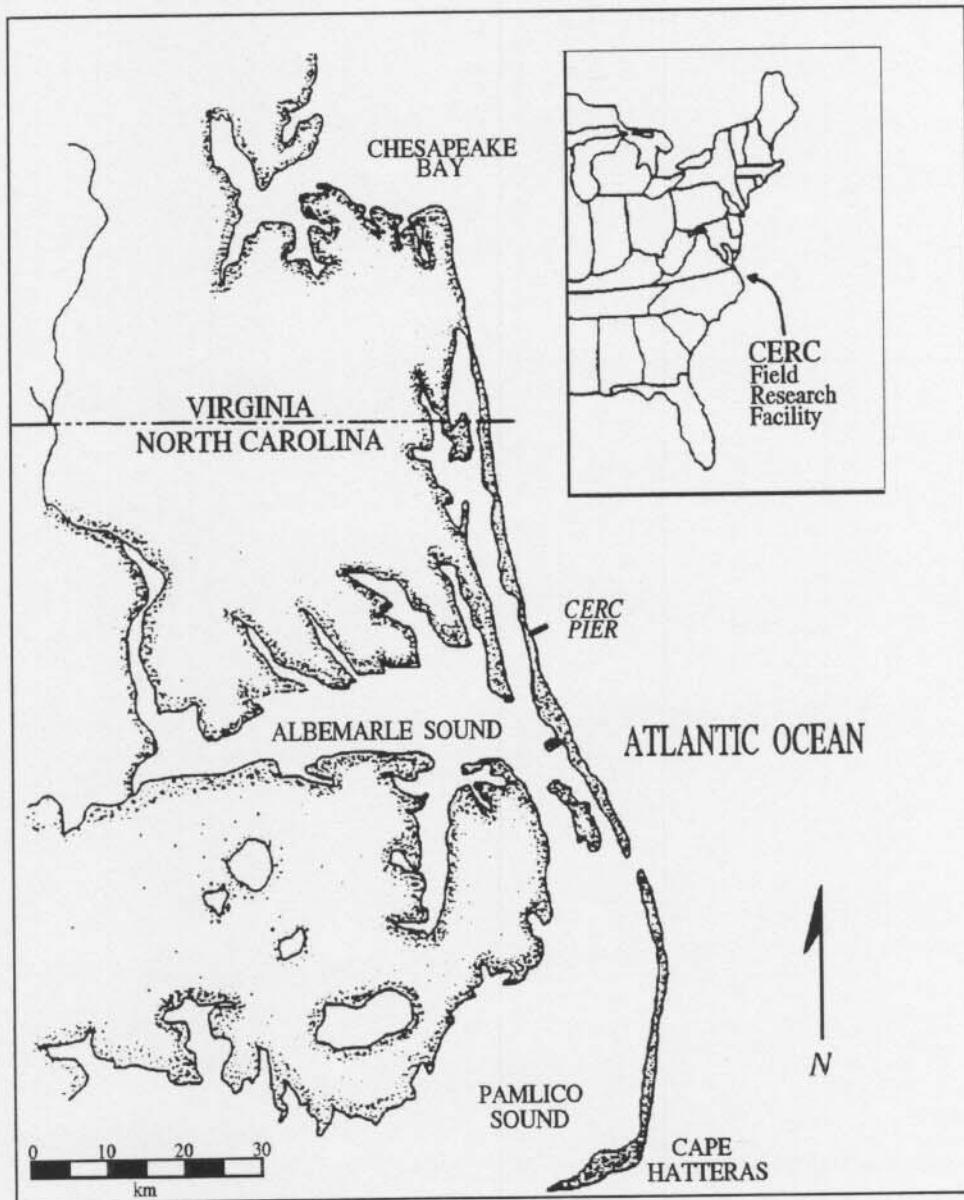


Figure 1. FRF Location Map

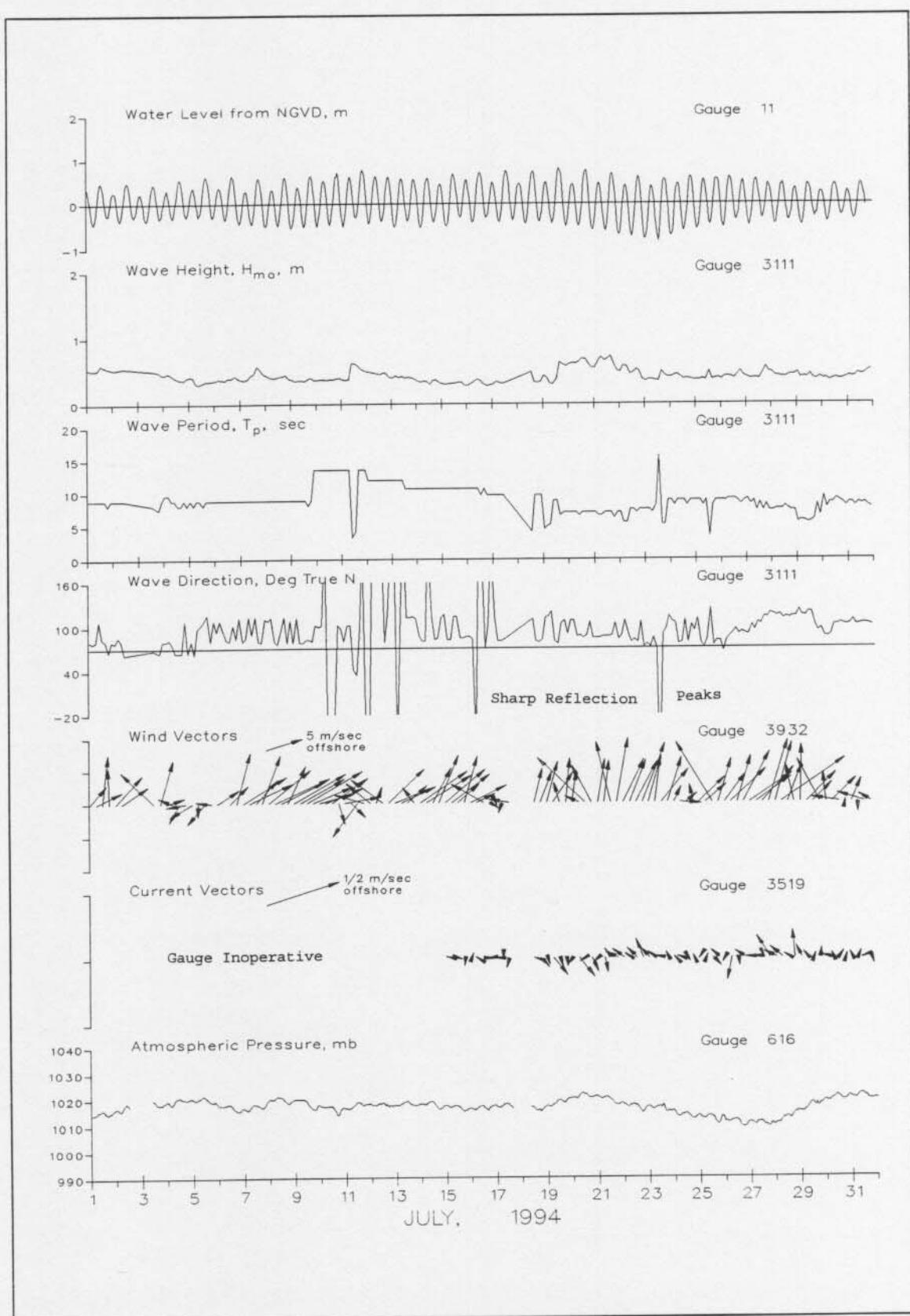


Figure 2. Month at a Glance

Table 1
Instrument Status/Data Availability

		July 1994																																					
		Day of the month																																					
Gauge ID	Description/Remarks	Gauge Status	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	3			
616	Atmospheric Pressure	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*			
		Data Collected	*	/	*	*	*	*	*	*	*	*	*	*	*	*	*	*	/	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*				
604	Precipitation	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*			
		Data Collected	*	/	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	/	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*			
624	Air Temperature	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		
		Data Collected	*	/	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	/	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		
3932	Anemometer	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		
		Data Collected	*	/	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	/	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		
641	Pressure Gauge on FRF pier	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		
		Data Collected	*	/	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	/	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		
625	Baylor staff on FRF pier	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		
		Data Collected	*	/	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	/	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		
3111	8 Meter Array 309 m north of FRF	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		
		Data Collected	*	/	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	/	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
111	Pressure Gauge center of 8 Meter Array	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
		Data Collected	*	/	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	/	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
630	Waverider buoy 4.0 km offshore	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
		Data Collected	*	/	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	/	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
3519	Current meter 434 m north of FRF pier (0.9 km offshore)	Gauge Status	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	/	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*			
		Data Collected	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	/	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*			
11	NOAA tide gauge at end of pier	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
		Data Collected	*	/	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	/	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
Visual Observations (daily oceanographic and meteorological observations)		Daily observation	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		
Gauge Status * = Operational / = Partial - = Non-Operational																																							
Data Collected * = All / = Partial - = None																																							
Visual Observations * = Complete / = Partial - = None																																							

Table 2
Gauge Locations

Gauge ID	Description	Latitude Degrees N	Longitude Degrees W	FRF Coordinates Crossshore m	Longshore m	Gauge Depth NGVD, m	Water Depth NGVD, m
616	Atmospheric Pressure	36 10' 45.48"	75 44' 37.39"	11.60	569.00	-----	-----
3932	Anemometer	36 11' 2.64"	75 44' 46.50"	585.20	517.30	19.50	-----
641	Pressure Gauge	36 10' 51.96"	75 44' 42.21"	239.11	516.64	-1.64	-1.96
625	Baylor Staff	36 11' 2.10"	75 44' 46.31"	568.00	516.64	Surface	-8.36
3111	8 Meter Array North	36 11' 17.59	75 44' 32.62"	915.23	990.16	-7.50	-7.90
	8 Meter Array South	36 11' 14.98	75 44' 42.30"	914.20	735.37	-7.42	-7.90
	8 Meter Array East	36 11' 16.88	75 44' 40.32"	954.51	800.58	-7.62	-8.13
	8 Meter Array West	36 11' 13.18"	75 44' 38.84"	834.66	800.37	-6.98	-7.44
111	Pressure Gauge in center of 8 M Array	36 11' 15.90"	75 44' 38.88"	914.43	825.52	-7.76	-8.08
630	Waverider Buoy	36 12' 16.44"	75 47' 19.23"	3934.96	-2400.81	Surface	-17.00
3519	Current Meter	36 11' 17.17"	75 44' 34.15"	914.76	950.00	-5.30	-7.90
11	NOAA Tide Gauge	36 11' 2.95"	75 44' 46.76	596.49	514.20	Surface	-7.62

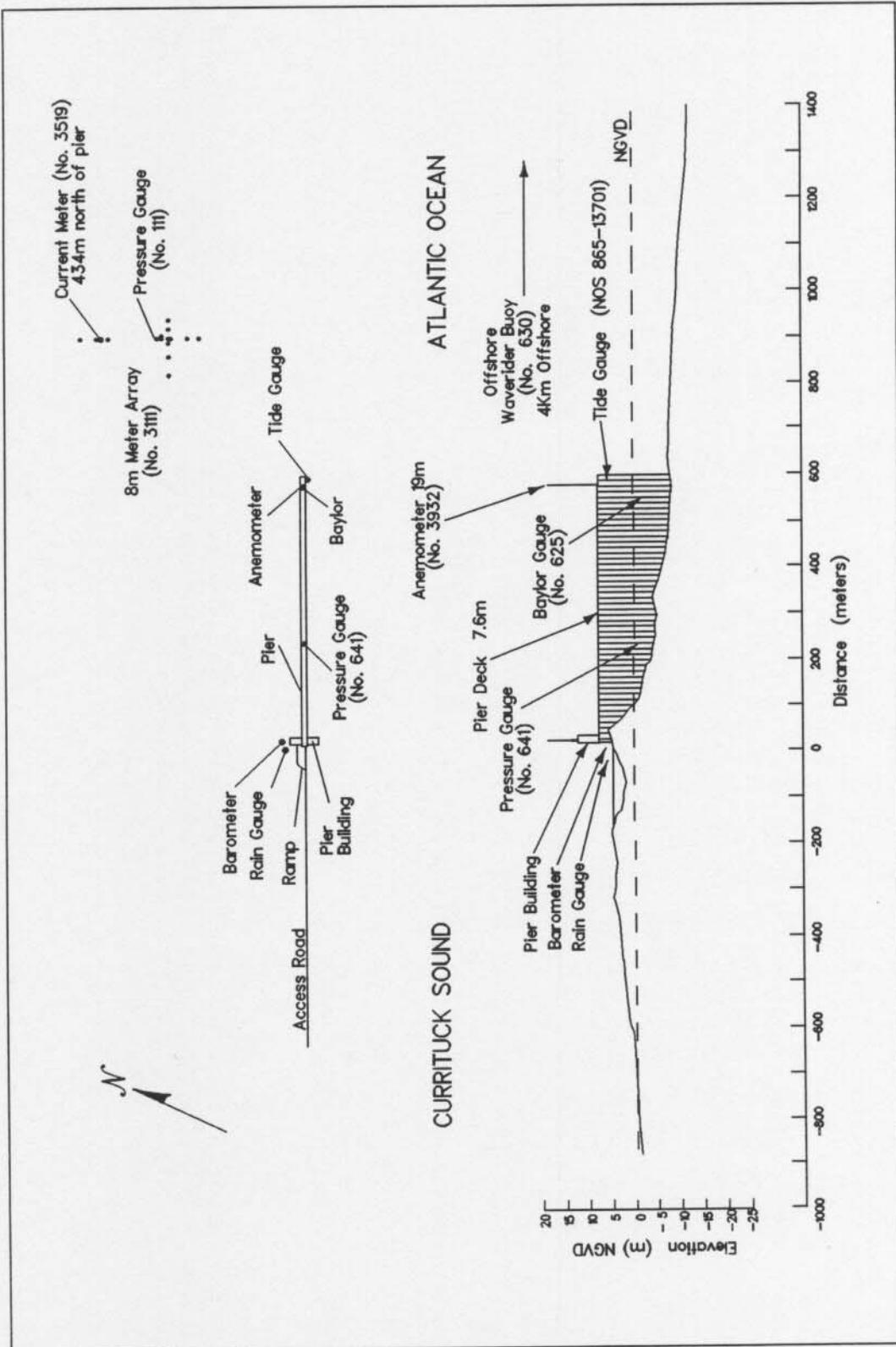


Figure 3. Instrument Locations, Elevations From NGVD

2 Meteorological Data

A variety of instruments have been installed at the FRF (Figure 3) to monitor the meteorological conditions. The data presented in Table 3 are collected and stored using a Digital Equipment Corporation VAX 11/750. For each instrument identified in Table 1, a log is maintained and the records are stored for future reference.

Winds were measured at the end of the pier at an elevation of 19 m (Figure 4) using a WeatherMeasure Skyvane anemometer. Monthly resultant wind speeds and directions are determined by vector averaging the data. Wind directions indicate where the wind is coming from. Temperature and atmospheric pressure means are the average of the values presented for the month. Total precipitation is the sum for the month.

The following may be useful for converting the data in Table 3 to other frequently used units of measurement:

1. Millimeters (mm) to inches (in.) -
 $mm \times .03937 = in.$
2. Millibars (mb) to inches of mercury (in. Hg) -
 $mb \times 0.02953 = in. Hg$
3. Degrees Celsius (C) to degrees Fahrenheit (F) -
 $(C \times 9/5) + 32 = F$
4. Meters per second (m/s) to knots (kn) -
 $m/s \times 1.943 = kn$

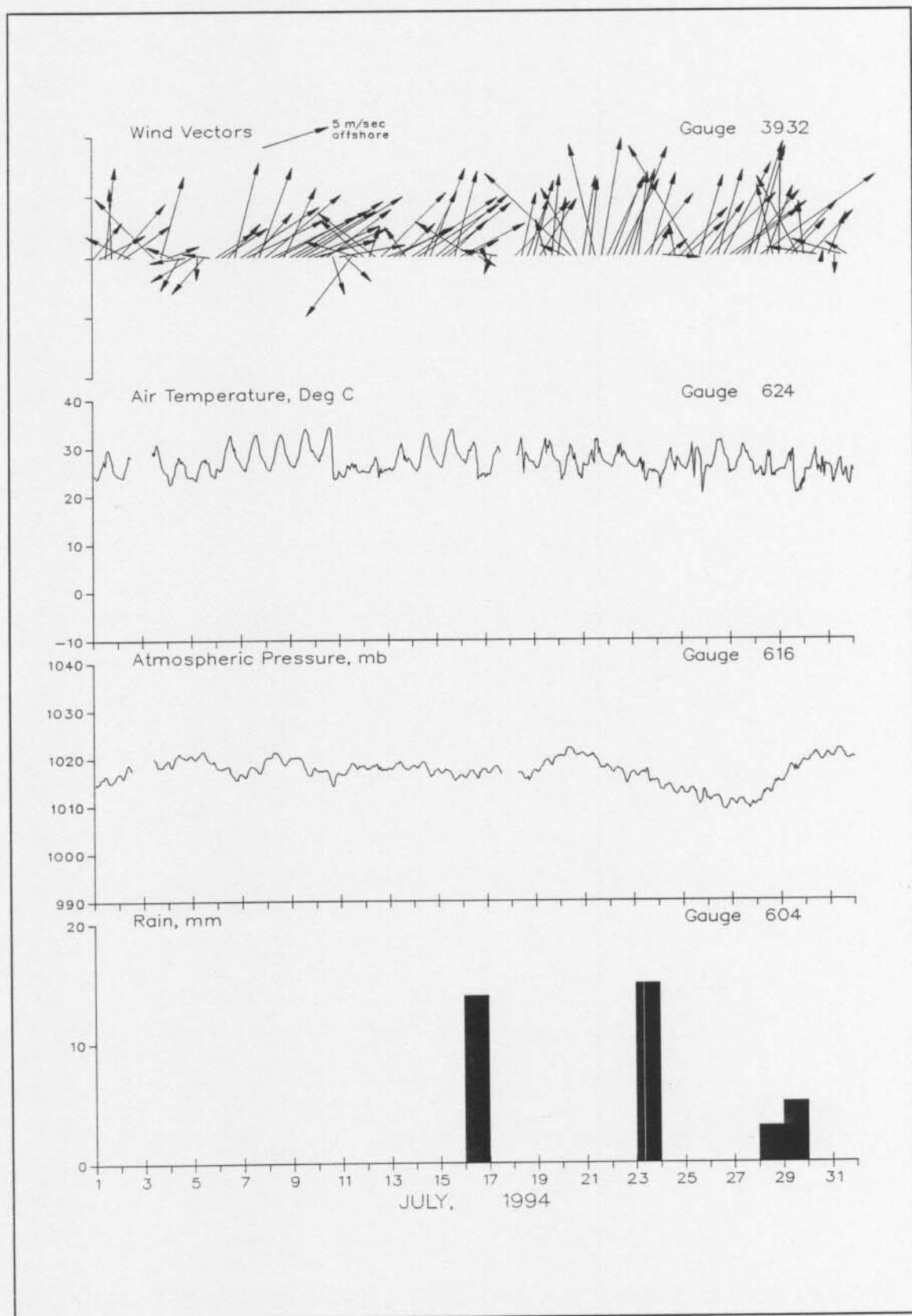


Figure 4. Meteorological Monthly Summary

Table 3
Meteorological Data

Jul 1994						
Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
1	100	4	215	24.3	1014.5	0
	700	4	240	25.4	1015.8	0
	1300	8	185	29.3	1015.8	0
	1900	6	178	26.7	1015.4	0
2	100	6	217	24.3	1016.9	0
	700	4	231	25.3	1017.7	0
	1300	4	119	28.2	1017.7	0
	1900					0
3	100		Hardware Error			0
	700					0
	1300	6	138	30.0	1019.2	0
	1900	7	194	26.2	1018.2	0
4	100	3	248	24.6	1019.5	0
	700	2	115	24.4	1020.2	0
	1300	3	25	27.6	1020.5	0
	1900	3	79	24.6	1020.2	0
5	100	4	55	24.0	1020.2	0
	700	2	2	25.3	1020.8	0
	1300	4	37	27.4	1020.6	0
	1900	2	98	24.8	1019.3	0
6	100	3	232	25.9	1017.9	0
	700	4	233	26.0	1018.0	0
	1300	4	220	31.9	1017.2	0
	1900	8	192	28.7	1015.6	0
7	100	7	234	26.3	1016.6	0
	700	6	241	26.9	1017.7	0
	1300	5	217	32.0	1017.9	0
	1900	8	197	29.1	1017.4	0
8	100	7	226	26.1	1020.3	0
	700	8	241	26.7	1021.3	0
	1300	7	239	32.0	1020.3	0
	1900	6	202	29.6	1019.0	0
9	100	8	236	26.4	1020.0	0
	700	7	237	27.4	1020.1	0
	1300	9	236	33.0	1018.0	0
	1900	6	244	31.4	1016.4	0
10	100	5	252	28.3	1017.4	0
	700	5	1	28.5	1017.3	0
	1300	6	230	33.7	1016.5	0
	1900	3	1	23.7	1016.3	0

Table 3
Meteorological Data (continued)

Jul 1994						
Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
11	100	5	258	24.7	1016.6	0
	700	3	318	25.4	1017.6	0
	1300	6	33	26.8	1018.6	0
	1900	4	108	25.0	1018.3	0
12	100	4	133	25.0	1017.8	0
	700	3	196	25.4	1018.4	0
	1300	5	130	27.5	1018.2	0
	1900	7	222	24.9	1017.6	0
13	100	5	245	25.6	1017.7	0
	700	5	241	26.1	1018.8	0
	1300	4	223	30.1	1018.4	0
	1900	3	147	26.9	1017.6	0
14	100	8	232	26.0	1018.3	0
	700	7	234	25.9	1018.9	0
	1300	6	204	32.2	1018.0	0
	1900	8	199	29.6	1016.5	0
15	100	7	225	26.7	1017.4	0
	700	7	229	27.0	1017.6	0
	1300	4	1	32.5	1016.8	0
	1900	7	193	30.3	1015.8	0
16	100	5	240	27.5	1016.2	0
	700	3	1	27.9	1017.0	0
	1300	5	124	31.0	1016.5	0
	1900	2	306	24.0	1017.2	14
17	100	0		23.8	1016.9	0
	700	2	17	26.5	1017.9	0
	1300	3	100	30.2	1017.4	0
	1900					0
18	100		Hardware Error			0
	700	6	221	28.3	1016.9	0
	1300	5	191	28.9	1015.7	0
	1900	5	198	27.4	1015.7	0
19	100	6	193	26.0	1017.3	0
	700	5	209	27.5	1018.3	0
	1300	3	166	30.2	1019.3	0
	1900	7	184	28.1	1020.0	0
20	100	5	186	26.8	1020.5	0
	700	2	117	25.8	1021.9	0
	1300	9	137	29.9	1021.6	0
	1900	6	155	24.9	1020.7	0

Table 3
Meteorological Data (concluded)

Jul 1994						
Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
21	100	7	188	26.4	1020.4	0
	700	6	185	28.1	1020.8	0
	1300	9	168	31.1	1019.3	0
	1900	10	188	27.3	1017.9	0
22	100	7	202	26.3	1017.7	0
	700	7	198	27.5	1017.7	0
	1300	7	204	30.5	1017.1	0
	1900	9	198	27.3	1015.4	0
23	100	7	193	25.8	1016.8	0
	700	7	185	27.2	1016.9	0
	1300	6	215	22.8	1017.6	15
	1900	7	195	24.9	1015.1	0
24	100	2	202	24.7	1014.2	0
	700	3	275	24.6	1014.0	0
	1300	2	226	29.1	1013.8	0
	1900	3	170	26.2	1012.5	0
25	100	5	221	25.8	1012.9	0
	700	4	225	26.6	1013.3	0
	1300	10	152	23.4	1012.7	0
	1900	7	194	27.9	1011.0	0
26	100	5	212	25.5	1011.4	0
	700	7	222	26.0	1011.8	0
	1300	7	194	30.9	1011.1	0
	1900	8	204	28.0	1009.5	0
27	100	7	231	24.9	1011.0	0
	700	6	230	26.6	1011.1	0
	1300	7	218	30.2	1010.2	0
	1900	10	194	27.2	1010.0	0
28	100	9	193	23.9	1010.7	0
	700	11	231	25.0	1012.6	0
	1300	6	198	28.4	1012.8	0
	1900	6	168	23.8	1015.1	3
29	100	9	180	25.0	1014.8	0
	700	6	220	26.1	1016.9	0
	1300	4	220	29.2	1017.5	0
	1900	7	155	20.7	1018.1	5
30	100	4	174	23.4	1019.1	0
	700	5	220	25.5	1020.2	0
	1300	4	99	25.8	1020.2	0
	1900	0		26.0	1020.0	0
31	100	4	200	26.0	1020.2	0
	700	2	359	24.0	1021.4	0
	1300	4	109	25.1	1021.0	0
	1900	2	124	22.8	1019.6	0
Resultant			Mean	Mean	Total	
	4	202	27.0	1017.1	37	

3 Wave Data

Wave data are collected from three different sets of instruments, as shown in Table 1 and Figure 3. The first is an array of fifteen pressure gauges, collectively referred to as gauge 3111 (gauge 111 being one of them). Directional information is computed from these gauges using a iterative maximum likelihood estimator. The second is a Baylor staff gauge (625) and a pressure gauge (641), both attached to the pier. The third is a Waverider buoy (630). The data are collected, analyzed, and stored on optical disc using a Digital Equipment Corporation VAX 4100 programmed to sample the gauges for two hour and forty-eight minute time frames. The sampling rate is two times per second which equals five contiguous 34 minute records per collection period. This report reflects the data collection periods of 0100, 0700, 1300, and 1900 EST. The results are based only on the first 34 minute record. The exception is the 8 Meter Array (3111) which condenses the first four records into one statistical value.

Wave height H_{mo} is an energy-based statistic equal to four times the standard deviation of the sea surface elevations. Wave height reported from the pressure gauge has been compensated for hydrodynamic attenuation using linear wave theory. Wave period is identified from the computation of a variance (energy) spectrum with 60 degrees of freedom calculated from a 34-min record. Peak wave period T_p is defined as the period associated with the maximum energy in the spectrum. When this analysis is complete, the data are written to optical disc.

Table 4 presents the wave heights and periods for each wave record obtained at 6 hr intervals during the month. The monthly means and standard deviations from the means shown in Table 4 are average values computed from this data. Figure 5 is a time history of all H_{mo} and T_p values obtained for all gauges.

Differences in wave periods between wave gauges (Table 4 and Figure 5) may be the result of wave breaking, wave reformation, the presence of multiple wave trains containing nearly equal energy, and statistical variations in spectral estimations.

Table 4
Wave Data

Jul 1994										
Day	Hour	641		625		3111			630	
		Pressure Gauge Hmo,m	Tp,sec	Baylor Gauge Hmo,m	Tp,sec	8 Meter Array Hmo,m	Tp,sec	Dir,TN	Waverider Hmo,m	Tp,sec
1	0100	0.51	6.6	0.50	16.0	0.54	8.9	80	0.69	9.2
	0700	0.42	6.1	0.53	9.2	0.52	8.9	80	0.63	8.9
	1300	0.47	8.6	0.51	8.6	0.60	8.9	84	0.69	9.2
	1900	0.46	8.6	0.57	8.9	0.55	8.2	66	0.67	8.3
	0100	0.47	8.6	0.51	8.3	0.53	8.9	78	0.63	7.8
2	0700	0.41	14.3	0.55	8.9	0.54	8.9	80	0.61	8.9
	1300	0.47	8.5	0.54	8.5	0.55	8.9	0	0.69	8.3
	1900									
	0100									
3	0700									
	1300	0.44	8.6	0.50	8.1	0.51	8.2	68	0.66	7.8
	1900	0.41	5.4	0.53	12.9	0.50	7.6	64	0.66	5.5
	0100	0.38	5.7	0.47	7.8	0.45	9.8	80	0.56	9.2
4	0700	0.37	8.6	0.51	9.5	0.45	8.9	76	0.57	8.6
	1300	0.34	8.3	0.41	9.2	0.39	8.2	64	0.48	8.9
	1900	0.32	7.8	0.35	8.3	0.37	8.9	108	0.45	9.2
	0100	0.35	6.1	0.41	8.3	0.42	8.9	80	0.51	5.4
5	0700	0.28	5.1	0.37	9.2	0.32	8.9	98	0.43	9.2
	1300	0.24	8.9	0.37	9.2	0.33	8.2	108	0.38	8.1
	1900	0.25	9.2	0.32	9.2	0.35	8.9	80	0.43	8.6
	0100	0.25	8.6	0.38	8.6	0.37	8.9	94	0.42	7.8
6	0700	0.28	7.8	0.35	8.5	0.38	8.9	0	0.44	9.1
	1300	0.28	8.9	0.39	7.8	0.40	8.9	80	0.43	7.8
	1900	0.37	9.2	0.47	9.2	0.43	8.9	84	0.61	9.2
	0100	0.29	8.9	0.40	8.9	0.38	8.9	80	0.48	8.9
7	0700	0.34	9.2	0.34	9.9	0.39	8.9	114	0.44	9.9
	1300	0.38	8.6	0.49	8.9	0.47	8.9	114	0.56	8.9
	1900	0.49	8.9	0.50	9.2	0.53	8.9	78	0.69	9.2
	0100	0.35	9.2	0.46	9.2	0.43	8.9	108	0.53	9.2
8	0700	0.32	9.2	0.38	9.2	0.40	8.9	80	0.51	8.9
	1300	0.31	8.9	0.41	8.9	0.42	8.9	92	0.45	8.9
	1900	0.40	8.9	0.41	8.6	0.44	8.9	78	0.54	8.6
	0100	0.28	15.1	0.35	9.2	0.38	8.9	78	0.43	9.2
9	0700	0.31	8.3	0.33	8.6	0.36	8.9	78	0.41	8.9
	1300	0.26	15.1	0.36	14.3	0.35	8.9	82	0.46	8.9
	1900	0.38	8.6	0.36	8.6	0.41	8.9	80	0.51	8.6
	0100	0.29	14.3	0.39	14.3	0.37	13.6	100	0.44	8.6
10	0700	0.34	8.9	0.34	14.3	0.38	13.6	242	0.43	13.5
	1300	0.28	14.3	0.39	13.5	0.38	13.6	256	0.43	14.3
	1900	0.31	14.3	0.37	12.9	0.39	13.6	102	0.52	12.9

Table 4
Wave Data (continued)

Jul 1994										
Day	Hour	641 Pressure Gauge			625 Baylor Gauge			3111 8 Meter Array		
		Hmo,m	Tp,sec	Hmo,m	Tp,sec	Hmo,m	Tp,sec	Dir,TN	Hmo,m	Tp,sec
11	0100	0.23	13.5	0.38	13.5	0.38	13.6	80	0.43	13.5
	0700	0.25	13.5	0.34	13.5	0.38	13.6	102	0.42	13.5
	1300	0.40	4.1	0.57	13.5	0.61	4.2	34	0.70	3.9
	1900	0.44	4.8	0.51	13.5	0.53	13.6	234	0.62	12.9
12	0100	0.34	5.0	0.58	12.9	0.49	12.0	280	0.57	12.2
	0700	0.31	12.9	0.48	12.9	0.48	12.0	0	0.54	12.2
	1300	0.29	11.2	0.51	12.2	0.45	12.0	240	0.52	12.9
	1900	0.30	11.2	0.44	12.2	0.47	12.0	116	0.59	12.2
13	0100	0.26	11.2	0.39	11.2	0.40	12.0	226	0.47	12.2
	0700	0.27	11.2	0.41	10.3	0.41	12.0	116	0.46	11.7
	1300	0.27	11.2	0.35	11.2	0.40	10.8	112	0.42	11.2
	1900	0.27	11.2	0.39	11.2	0.40	10.8	114	0.53	10.7
14	0100	0.25	11.2	0.33	10.7	0.35	10.8	86	0.46	11.2
	0700	0.24	11.2	0.33	11.2	0.35	10.8	80	0.40	10.3
	1300	0.22	11.2	0.26	11.2	0.30	10.8	114	0.36	10.7
	1900	0.26	11.2	0.38	10.3	0.37	10.8	84	0.51	10.3
15	0100	0.24	10.7	0.30	10.3	0.31	10.8	116	0.43	10.3
	0700	0.23	11.2	0.32	10.7	0.30	10.8	82	0.36	10.3
	1300	0.27	9.9	0.30	9.9	0.32	10.8	114	0.40	11.2
	1900	0.26	8.9	0.42	10.3	0.33	10.8	84	0.47	10.3
16	0100	0.23	10.3	0.24	10.3	0.29	10.8	86	0.38	10.3
	0700	0.27	6.0	0.36	10.3	0.34	10.8	282	0.40	6.0
	1300	0.32	10.7	0.34	10.3	0.35	9.8	226	0.49	10.7
	1900	0.21	10.3	0.32	10.3	0.28	9.8	102	0.38	10.3
17	0100	0.24	8.9	0.28	10.3	0.30	9.8	114	0.37	9.2
	0700	0.24	9.2	0.38	10.3	0.33	9.8	80	0.38	9.9
	1300	0.26	8.3	0.29	8.6	0.31	9.7	0	0.38	10.3
	1900	Hardware Error								
18	0100									
	0700	0.28	8.0	0.41	10.2	0.36	9.1	100	0.47	9.8
	1300	0.34	7.6	0.35	9.5	0.48	4.2	110	0.61	3.9
	1900	0.29	7.4	0.32	9.9	0.33	9.8	78	0.47	9.5
19	0100	0.34	4.6	0.38	4.6	0.43	4.6	112	0.58	4.5
	0700	0.31	5.3	0.33	5.1	0.31	5.3	120	0.44	5.0
	1300	0.29	7.4	0.31	9.2	0.38	8.9	76	0.42	4.9
	1900	0.60	6.1	0.59	7.6	0.59	7.1	108	0.74	6.8
20	0100	0.54	7.0	0.58	7.0	0.61	7.1	108	0.84	7.2
	0700	0.60	7.0	0.59	7.4	0.61	7.1	86	0.80	7.2
	1300	0.58	6.5	0.66	6.3	0.68	7.1	84	0.83	6.6
	1900	0.58	7.4	0.56	7.2	0.60	7.1	106	0.78	7.4

Table 4
Wave Data (concluded)

Jul 1994											
Day	Hour	641		625		3111			630		
		Pressure Gauge Hmo,m	Tp,sec	Baylor Gauge Hmo,m	Tp,sec	8 Meter Array Hmo,m	Tp,sec	Dir,TN	Waverider Hmo,m	Tp,sec	
21	0100	0.49	7.0	0.55	7.0	0.55	7.1	84	0.72	7.0	
	0700	0.65	6.3	0.64	6.8	0.70	6.6	86	0.84	5.6	
	1300	0.55	6.8	0.68	6.8	0.68	7.1	86	0.81	6.8	
	1900	0.55	7.2	0.50	7.0	0.60	6.2	104	0.84	7.0	
22	0100	0.41	5.9	0.41	7.6	0.48	7.1	88	0.67	7.4	
	0700	0.57	5.4	0.55	5.6	0.56	5.6	90	0.71	5.5	
	1300	0.38	5.3	0.43	8.1	0.47	7.6	82	0.56	7.8	
	1900	0.44	7.4	0.45	7.8	0.48	7.6	106	0.73	5.4	
23	0100	0.28	5.6	0.30	7.6	0.34	7.6	76	0.43	7.2	
	0700	0.34	8.9	0.38	7.4	0.37	7.1	84	0.44	7.8	
	1300	0.28	5.4	0.29	7.6	0.35	15.7	250	0.43	7.6	
	1900	0.38	6.3	0.39	4.9	0.44	5.3	96	0.59	5.3	
24	0100	0.33	5.6	0.37	9.5	0.41	8.9	106	0.55	8.6	
	0700	0.39	5.6	0.44	8.9	0.45	8.9	76	0.56	5.9	
	1300	0.31	5.7	0.39	15.1	0.37	8.9	108	0.44	8.6	
	1900	0.34	8.9	0.33	8.9	0.38	8.9	102	0.45	8.6	
25	0100	0.27	9.2	0.37	15.1	0.36	8.9	110	0.42	8.3	
	0700	0.31	8.9	0.34	8.6	0.38	8.2	72	0.44	8.6	
	1300	0.35	8.9	0.55	2.8	0.49	3.5	124	0.66	8.6	
	1900	0.31	8.9	0.31	9.2	0.39	8.9	80	0.41	8.6	
26	0100	0.26	9.5	0.39	9.5	0.37	8.9	66	0.47	9.2	
	0700	0.30	8.9	0.39	8.9	0.41	9.2	85	0.48	8.9	
	1300	0.31	8.9	0.40	8.9	0.39	9.2	95	0.50	9.5	
	1900	0.38	8.3	0.47	9.5	0.49	8.3	92	0.65	8.6	
27	0100	0.34	7.4	0.40	9.2	0.40	9.2	88	0.53	7.8	
	0700	0.35	7.8	0.40	8.9	0.38	8.9	94	0.52	8.3	
	1300	0.33	7.6	0.38	8.1	0.38	8.6	102	0.47	9.9	
	1900	0.41	7.4	0.45	7.8	0.55	8.3	111	0.77	5.5	
28	0100	0.43	7.4	0.45	7.8	0.46	7.4	115	0.73	4.5	
	0700	0.37	7.2	0.41	7.6	0.41	7.6	115	0.57	7.2	
	1300	0.38	8.3	0.37	8.3	0.40	8.1	112	0.54	6.3	
	1900	0.35	7.2	0.41	7.6	0.43	7.4	112	0.52	7.6	
29	0100	0.40	5.5	0.42	6.0	0.46	5.6	122	0.64	5.4	
	0700	0.33	5.1	0.45	5.5	0.40	5.7	113	0.48	5.5	
	1300	0.39	5.9	0.42	5.4	0.44	5.6	118	0.61	5.6	
	1900	0.33	6.0	0.38	7.8	0.37	8.3	93	0.50	5.9	
30	0100	0.32	5.4	0.38	5.4	0.38	9.5	85	0.49	5.3	
	0700	0.29	8.6	0.41	8.6	0.34	8.6	87	0.40	8.9	
	1300	0.33	8.9	0.38	8.9	0.38	9.2	102	0.47	8.9	
	1900	0.31	8.9	0.39	8.9	0.37	8.6	101	0.44	8.6	
31	0100	0.35	8.6	0.39	8.6	0.41	8.6	102	0.45	8.6	
	0700	0.34	7.4	0.45	9.2	0.40	8.1	101	0.48	8.1	
	1300	0.40	8.9	0.40	8.3	0.44	8.3	103	0.53	8.1	
	1900	0.33	8.3	0.46	8.3	0.49	8.1	101	0.49	7.8	
Mean		0.35	8.5	0.42	9.3	0.43	9.0	102	0.53	8.6	
Std dev		0.09	2.4	0.09	2.3	0.09	2.1	48	0.12	2.2	

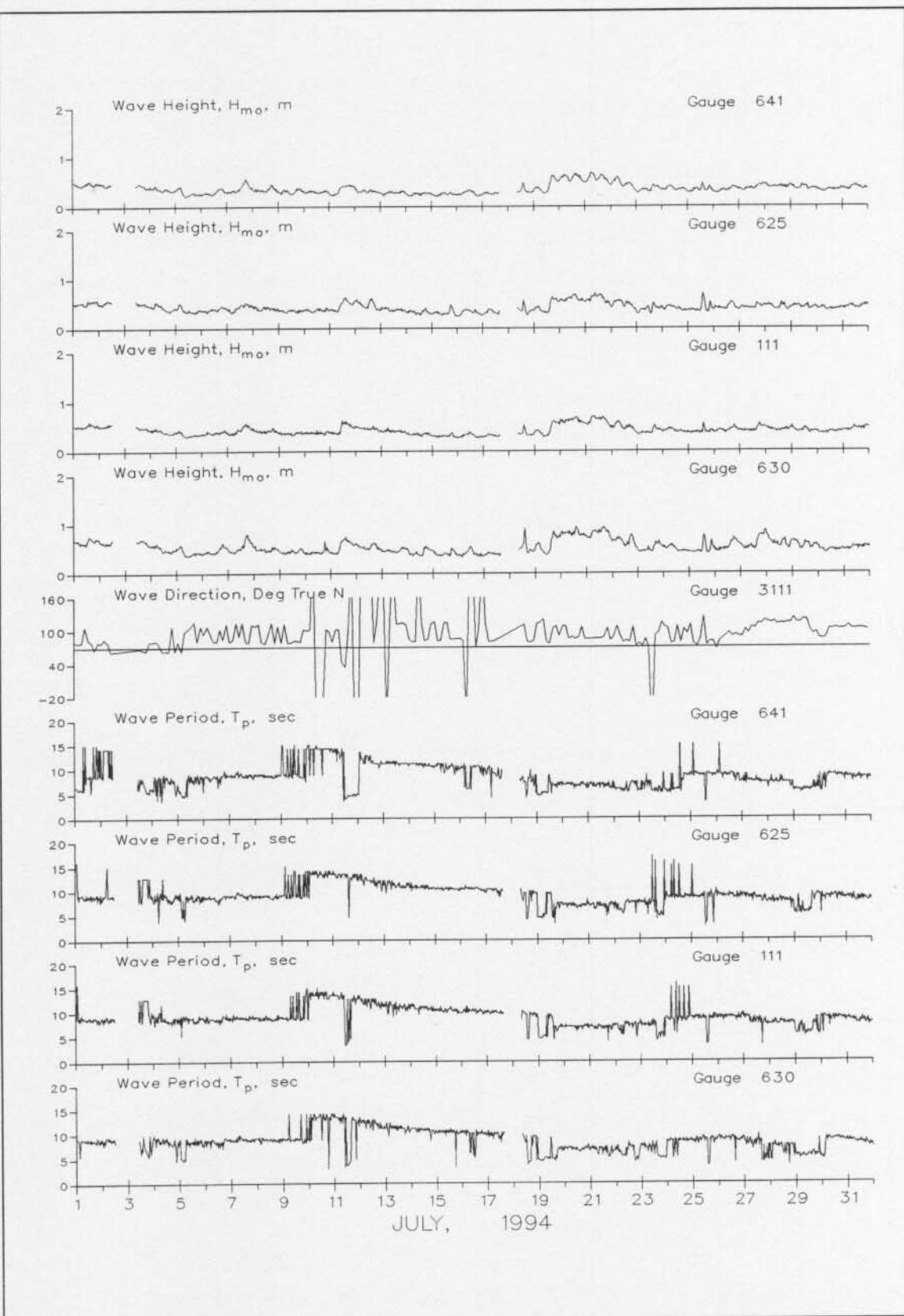


Figure 5. Wave Heights and Periods

4 Current Data

Current data (Table 5) are collected from a Marsh-McBirney electromagnetic biaxial current meter and by visually observing the movement of small drogues on the water surface in the surf and at the seaward end of the pier, as well as 500 m updrift of the pier, approximately 12 m offshore (Table 6).

Since the shoreline orientation is approximately N20W, longshore currents flow either toward 340 deg (i.e. northward) or toward 160 deg (i.e. southward). Similarly, cross-shore currents are either onshore (westward) or off-shore (eastward). All current speeds are given in centimeters per second (cm/sec). Resultant speeds and directions are determined by vector averaging the cross-shore and longshore data. Current directions indicate the direction that the current is moving towards. Current data are plotted in Figure 2.

Table 5
Current Meter Data - Gauge 3519

JULY 1994											
Day	Cross Long			Cross Long			Cross Long			Dir	
	Time	Shore	Shore	Speed	Shore	Shore	Speed	Shore	Shore		
1 100					1300			22 100	-4	-8	10 309
700					1900			700	-1	-3	4 308
1300					12 100	Gauge		1300	-3	-8	10 318
1900					700			1900	0	-14	15 340
2 100					1300			23 100	-2	-8	9 320
700					1900			700	-3	-5	7 306
1300					13 100	Inoperative		1300	-4	-2	5 281
1900					700			1900	0	-4	5 334
3 100					1300			24 100	0	0	0 0
700					1900			700	-1	-1	3 293
1300					14 100			1300	0	3	3 152
1900					700			1900	0	-1	2 337
4 100	Gauge				1300			25 100	0	1	1 210
700					1900			700	1	-1	2 17
1300					15 100			1300	3	8	9 141
1900					700	-3	-2	1900	-2	-6	8 315
5 100					1300	2	2	26 100	-2	3	4 208
700					1900	-2	5	700	-8	15	18 190
1300					16 100	3	-2	1300	0	7	7 171
1900					700	0	0	1900	-4	-6	8 305
6 100	Inoperative				1300	7	3	27 100	-2	-1	4 275
700					1900	-2	0	700	-2	0	3 267
1300					17 100	0	0	1300	0	1	1 159
1900					700	0	1	1900	-2	-17	18 331
7 100					1300	-4	6	28 100	-5	-6	9 296
700					1900			700	-4	-9	11 312
1300					18 100	Hardware Error		1300	-1	-2	4 305
1900					700			1900	5	-19	20 355
8 100					1300	0	0	29 100	0	-8	9 337
700					1900	3	8	700	0	-3	5 322
1300					19 100	0	5	1300	1	-1	3 16
1900					700	4	15	1900	3	-5	7 8
9 100					1300	0	7	30 100	-2	-1	4 286
700					1900	-1	6	700	0	-2	3 340
1300					20 100	-4	4	1300	4	-2	5 30
1900					700	4	17	1900	1	-1	2 13
10 100					1300	-4	1	31 100	0	-3	4 336
700					1900	0	11	700	3	-2	4 19
1300					21 100	-4	2	1300	-1	0	2 247
1900					700	-1	12	1900	0	6	6 162
11 100					1300	-1	-7	1900	0	6	6 162
700					1900	-5	-6	700	-5	-6	
											297

KEY:

- +cross-shore = offshore, cm/sec
- cross-shore = onshore, cm/sec
- +longshore = south, cm/sec
- longshore = north, cm/sec
- Speed = Resultant speed, cm/sec
- Dir = Resultant direction, degrees true north

Table 6
Visually Observed Current Data

Jul 1994											
Day	Pier End				Mid-Surf Zone				Beach		
	Cross Shore	Long Shore	Speed	Dir	Cross Shore	Long Shore	Speed	Dir	Location	Speed	Dir
1	0	0	0		0	-10	10	340	South	11	N
2	0	0	0		0	-27	27	340	South	9	N
3	no observation				0	-24	24	340	South	8	N
4	0	0	0		0	0	0		South	9	N
5	0	87	87	160	0	32	32	160	North	23	S
6	no observation				0	0	0		North	0	
7	0	0	0		0	0	0		South	0	
8	0	0	0		0	0	0		South	0	
9	0	0	0		0	0	0		South	0	
10	0	0	0		0	0	0		South	0	
11	0	87	87	160	0	47	47	160	South	29	S
12	0	0	0		0	0	0		South	0	
13	0	0	0		0	0	0		South	3	N
14	no observation				no observation				South	0	
15	0	0	0		0	0	0		South	0	
16	0	0	0		0	0	0		North	0	
17	0	41	41	160	0	24	24	160	South	5	S
18	0	20	20	160	0	-17	17	340	South	0	
19	0	0	0		0	-13	13	340	South	3	N
20	0	0	0		0	0	0		South	10	N
21	0	-14	14	340	0	-20	20	340	South	18	N
22	0	-24	24	340	0	-21	21	340	South	23	N
23	5	-27	27	351	2	-21	21	346	South	6	N
24	6	15	16	70	0	0	0		South	12	N
25	0	-8	8	340	0	-7	7	340	South	0	
26	0	24	24	160	0	14	14	160	North	11	S
27	0	-18	18	340	0	-12	12	340	South	0	
28	0	-20	20	340	0	-24	24	340	South	24	N
29	0	-20	20	340	0	-17	17	340	South	3	N
30	0	-24	24	340	0	0	0		South	0	
31	0	-28	28	340	0	-23	23	340	no observation		

KEY:

- +cross-shore = offshore, cm/sec
- cross-shore = onshore, cm/sec
- +longshore = south, cm/sec
- longshore = north, cm/sec
- Speed = Resultant speed, cm/sec

5 Visual Observations

Visual wave direction measurements (Table 7) of both the primary wave train (i.e. that having the higher wave heights) and the secondary wave train (which must be clearly distinguishable as a wave train separate from the primary waves but not surface chop or capillary waves) are taken daily at the seaward end of the pier. The direction of the primary wave train just north of the seaward end of the pier is also determined using a Raytheon Marine Pathfinder radar and measuring the alignment of the wave crests at approximately the same location as the visual measurements. The pier axis (considered perpendicular to the beach at the FRF) is oriented 70 deg east of true north; consequently, wave angles greater than 70 deg indicate that the waves were coming from the south side of the pier.

The width of the surf zone (seawardmost breaker position to shoreline) is determined from the pier deck.

Measurements of surface water temperature, density, and visibility are also taken daily at the seaward end of the pier. A Bucket Thermometer is lowered about 0.3 m into the water and allowed to remain for at least one minute. The temperature is then read, and a hydrometer is used to determine the density. A Secchi disc is used to determine the depth of visibility.

Table 7
Visual Observations

Day	Time	Wave Approach Angle at Pier End deg from True N		Radar Wave Angle deg from True N	Width of Surf Zone,m	Water Characteristics at Pier End		
		Primary	Secondary			Temp.,C	Density g/cc	Secchi Vis.,m
1	0615	110			7	22.2	1.0227	2.1
2	0840	100			4	23.1	1.0226	3.0
3	0750	105			9	23.3	1.0226	3.0
4	1005	110			9	24.4	1.0226	4.0
5	0630	100			5	24.4	1.0200	3.0
6	0630	120			2	25.0	1.0200	3.7
7	0630	110			2	23.3	1.0224	3.7
8	0615	105			2	22.7	1.0226	2.4
9	0930	110			11	21.1	1.0226	2.4
10	0755	100			2	22.2	1.0226	2.4
11	0615	100			4	26.1	1.0222	3.7
12	0615	70	50		0	26.4	1.0220	3.7
13	0615	95			5	26.1	1.0222	3.0
14	0620	110			2	23.0	1.0225	3.0
15	0615	130			2	21.1	1.0227	3.0
16	0900	105			2	22.5	1.0226	2.1
17	1130	130	100		5	27.2	1.0200	3.7
18	0640	120	100		7	26.7	1.0200	3.7
19	0630	120	100		7	22.2	1.0223	3.7
20	0640	115			7	21.1	1.0224	1.8
21	0620	105		105	12	19.7	1.0225	1.8
22	0630	110		100	7	16.7	1.0225	2.1
23	0650	90	120	90	12	15.6	1.0266	3.4
24	0725	95	120		9	16.7	1.0260	3.4
25	0630	110			4	16.7	1.0260	2.4
26	0630	120	90		5	18.9	1.0250	3.4
27	0630	145	120		10	17.7	1.0260	4.0
28	0655	140	120		5	15.6	1.0265	3.0
29	0630	120			7	17.2	1.0260	3.0
30	1000	125	100		4	18.3	1.0261	5.2
31	1015	105			9	21.7	1.0255	3.7

6 Water Levels

Since 1978, the National Oceanic and Atmospheric Administration (NOAA)/National Ocean Service (NOS) has operated a primary tide station (No. 865-1370) at the seaward end of the FRF pier. A NOS acoustic tide gauge (Next Generation Water Level Measurement System, NGWLMS) is used to collect water level data every 6 minutes throughout the month.

The variation in water level during the month is shown in Figure 6 along with a list of means and extreme values. This presentation is useful in identifying effects of both meteorological and astronomical forces on the open coast water level. Table 8 contains the range, high, low, and mean water level for each 12.42-hr tidal cycle.

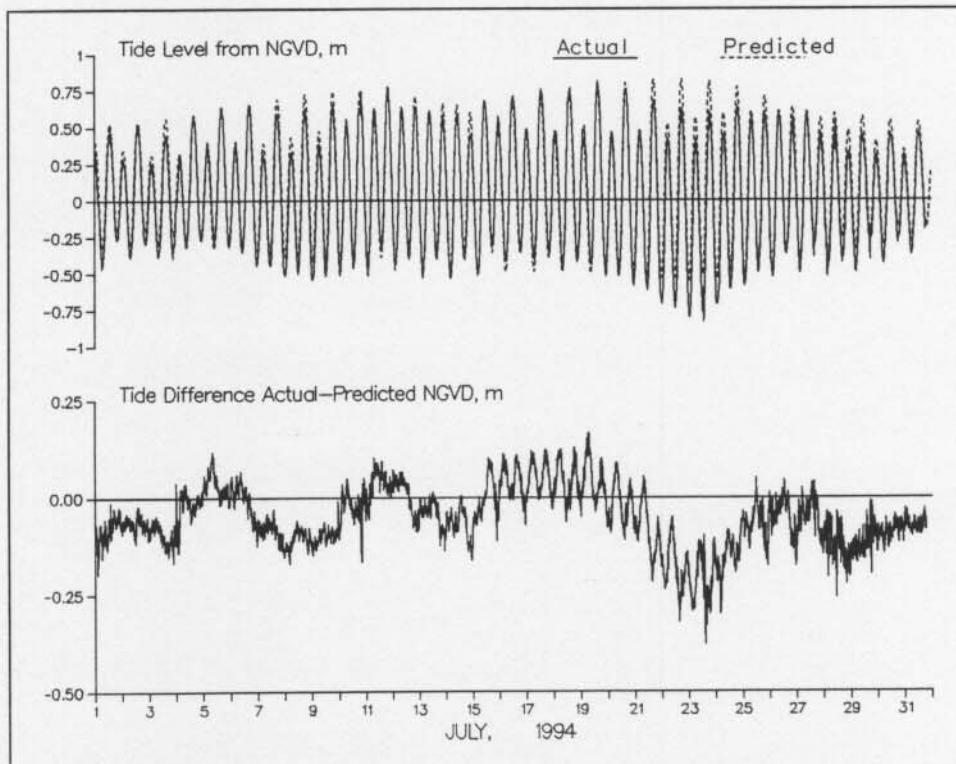


Figure 6. Water Level Variation

Table 8
Water Levels, m NGVD

JUL 1994 Tide Levels															
High				Low				High							
Day	Time	m	Day	Time	m	m	m	Day	Time	m	Day				
1	0100	0.33	1	0624	-0.47	-0.10	0.80	16	1324	0.71	16	1942	-0.36	0.19	1.07
1	1354	0.51	1	2012	-0.27	0.09	0.78	17	0130	0.48	17	0800	-0.41	0.05	0.89
2	0142	0.28	2	0754	-0.39	-0.04	0.67	17	1424	0.76	17	2100	-0.38	0.20	1.14
2	1448	0.51	2	2112	-0.30	0.09	0.81	18	0224	0.47	18	0824	-0.46	0.03	0.93
3	0248	0.25	3	0830	-0.39	-0.06	0.64	18	1536	0.77	18	2130	-0.43	0.18	1.20
3	1512	0.44	3	2142	-0.40	0.05	0.84	19	0412	0.51	19	1018	-0.45	0.04	0.96
4	0400	0.32	4	0948	-0.32	-0.01	0.64	19	1606	0.81	19	2306	-0.52	0.15	1.34
4	1612	0.57	4	2300	-0.28	0.14	0.85	20	0442	0.46	20	1030	-0.52	-0.02	0.99
5	0412	0.40	5	1024	-0.30	0.06	0.70	20	1712	0.76	21	0000	-0.59	0.10	1.35
5	1706	0.64	5	2336	-0.32	0.16	0.96	21	0606	0.47	21	1212	-0.62	-0.06	1.09
6	0530	0.40	6	1054	-0.35	0.03	0.76	21	1806	0.69	22	0054	-0.71	-0.02	1.40
6	1724	0.65	7	0006	-0.45	0.10	1.10	22	0648	0.42	22	1254	-0.74	-0.15	1.16
7	0536	0.32	7	1200	-0.45	-0.05	0.77	22	1854	0.63	23	0136	-0.81	-0.09	1.43
7	1754	0.60	8	0112	-0.51	0.04	1.11	23	0730	0.42	23	1400	-0.84	-0.17	1.26
8	0654	0.33	8	1224	-0.50	-0.07	0.83	23	1942	0.61	24	0130	-0.72	-0.07	1.33
8	1836	0.63	9	0100	-0.55	0.04	1.17	24	0754	0.44	24	1400	-0.61	-0.07	1.06
9	0730	0.38	9	1306	-0.52	-0.05	0.90	24	2018	0.65	25	0236	-0.59	0.02	1.24
9	1930	0.65	10	0154	-0.51	0.08	1.17	25	0918	0.57	25	1448	-0.50	0.05	1.07
10	0754	0.56	10	1348	-0.47	0.05	1.02	25	2024	0.61	26	0400	-0.53	0.05	1.14
10	2106	0.75	11	0248	-0.52	0.12	1.26	26	0954	0.59	26	1600	-0.37	0.11	0.96
11	0830	0.63	11	1412	-0.32	0.14	0.95	26	2230	0.57	27	0412	-0.50	0.02	1.07
11	2054	0.78	12	0312	-0.44	0.16	1.22	27	1030	0.60	27	1618	-0.39	0.12	0.99
12	0918	0.64	12	1542	-0.40	0.12	1.04	27	2218	0.47	28	0424	-0.52	-0.01	0.99
12	2218	0.64	13	0412	-0.53	0.06	1.17	28	1148	0.53	28	1736	-0.43	0.03	0.97
13	0936	0.58	13	1642	-0.41	0.09	0.99	29	0000	0.33	29	0548	-0.50	-0.07	0.83
13	2218	0.58	14	0436	-0.54	0.01	1.12	29	1106	0.47	29	1824	-0.41	0.07	0.88
14	1136	0.58	14	1800	-0.41	0.09	0.99	29	2312	0.30	30	0548	-0.44	-0.04	0.74
14	2348	0.45	15	0536	-0.52	-0.02	0.96	30	1218	0.45	30	1848	-0.30	0.09	0.75
15	1142	0.68	15	1824	-0.32	0.18	1.00	31	0036	0.31	31	0642	-0.38	-0.03	0.69
16	0018	0.57	16	0642	-0.42	0.06	0.99	31	1318		31	2006	No data this cycle		

7 Bathymetry

A. Nearshore Profiles. In order to document profile response away from the pier, surveys of four profile lines extending 900 to 1,000 m from shore and located 489 and 581 m north and 517 and 608 m south of the FRF pier are conducted bi-weekly, after storms, and during more complete bathymetric surveys.

These profiles are obtained using the CRAB-Geodimeter surveying system; a Geodimeter 140-T self-tracking, electronic theodolite, distance meter, in combination with the Coastal Research Amphibious Buggy (CRAB), a 10.7 m high, self-powered, mobile tripod on wheels.

Figure 7 shows the last survey in June 1994 and the survey(s) in July 1994 on profile line 188, located 517 m south of the pier.

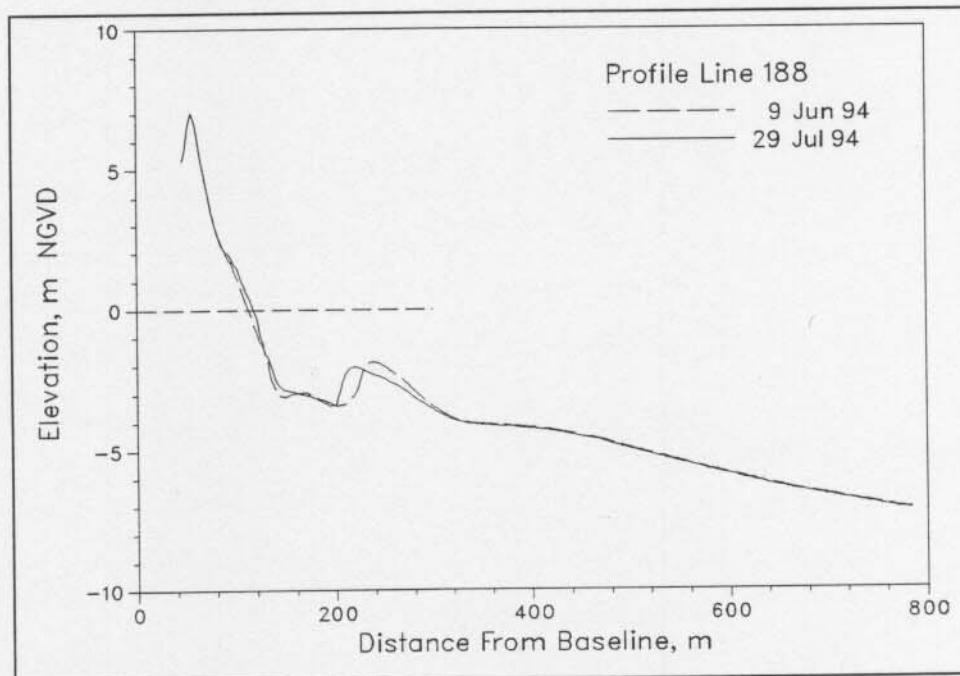


Figure 7. Monthly CRAB Profiles on Profile Line 188.

The profile envelope (Figure 8) reflects the maximum changes that occurred on the profile during 1994. Cross-hatched areas indicate changes to the annual envelope which occurred in July.

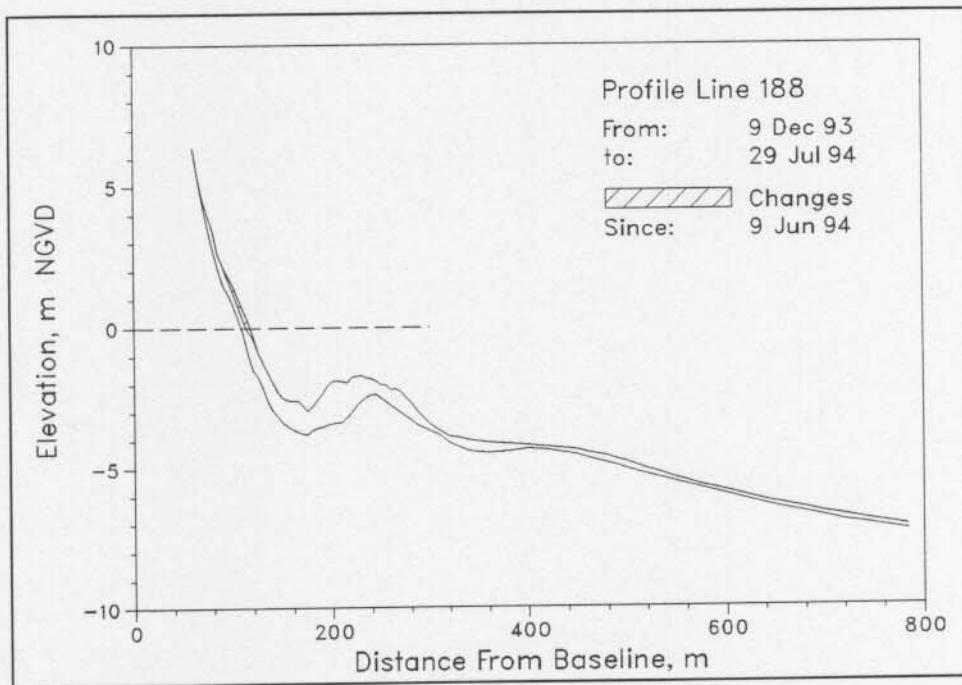


Figure 8. Profile Envelope - Profile Line 188.

B. Bathymetry. Figure 9 includes a two- and three-dimensional contour map and a change plot derived from the bathymetric survey on 30 July. Wide contour lines on the change diagram represent eroded areas; thin lines indicate deposition. The surveys were done on 29-30 July. Figure 7 and Figure 8 show 29 July, Figure 9 shows 30 July.

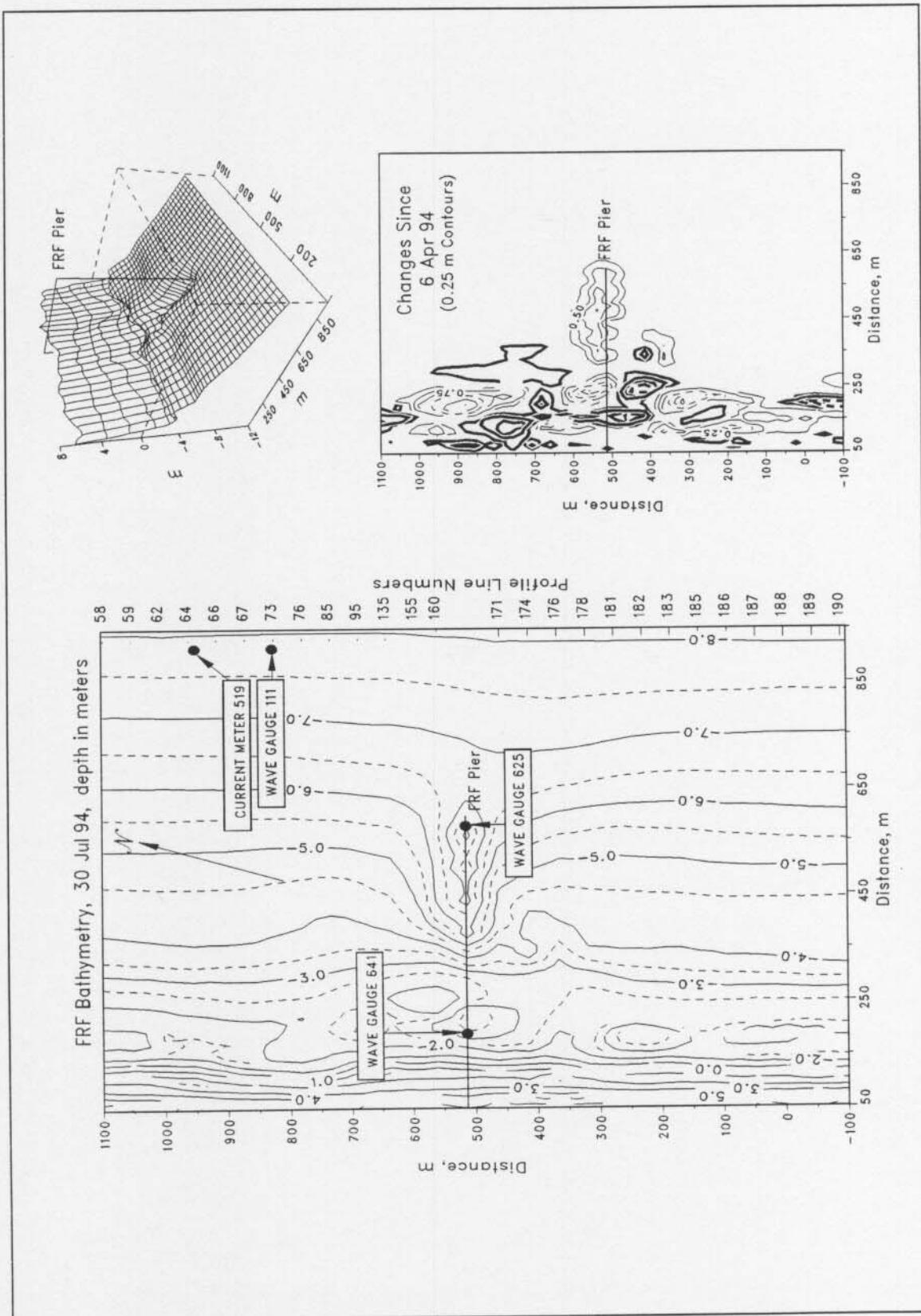


Figure 9. FRF Bathymetry, Depths Relative to NGVD

Distribution List

Government Agencies:

Back Bay National Wildlife Refuge
USACE-OCE
USACE-SAD
USACE-NAP
USACE-SAW
USACE-WES
NAVSAC
NOAA/NOS/OMS
National Marine Fisheries

U.S. Geological Survey
U.S. Library of Congress
U.S. National Park Service
U.S. National Weather Service
U.S. Naval Academy
U.S. Naval Civil Eng. Lab
U.S. Naval Oceanographic Off.
U.S. Naval Research Lab

Colleges/Universities:

Bucknell University
California Inst. of Tech.
Duke Marine Lab
East Carolina University
Florida Inst. of Tech.
M.I.T.
Naval Post Graduate School
NC State University
Old Dominion University
Oregon State University
Prince George's College

Scripps Institution of Oceanography
Stockton State College
University Calif-Berkeley
University of Florida
University of Maryland-College Park
University of Maryland-Baltimore
University of North Carolina
University of N C-Seagrant Program
University of Virginia
Va. Inst. of Marine Science
Rutgers University

Others:

Allied Signal Aerospace Co.
Applied Physics Lab
Cape Hatteras Nat. Seashore
Coastal and Est. Res., Inc.
Coastal Science & Eng., Inc.
Dr. Cy Galvin
GEOMET Tech., Inc.
Mr. Hodges
Dr. Hylton
Mr. Mason
Mr. Rodgers

WCTI-TV
MEC Systems Corporation
Moffatt & Nichol, Eng.
N.C. Div. Coastal Management
Oregon Inlet & Waterways Commis.
Raleigh-Durham Airport
Mr. Rowland
Mr. Savage
Science Application Int'l. Corp
Sherwood Industries
SEASUN Power Systems

Foreign:

Christchurch, Barbados
Ministry of Works, Bahamas
Dalhousie University, Halifax Nova Scotia
Queen's University, Ontario (Canada)
Ministry of Construction, Coastal Division (Japan)
Norwegian Hydrodynamic Laboratories (Norway)
University of Sydney (Australia)